# Sediment Volume Inhomogeneities, Patterns, Mechanisms and Rates of Change

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## LONG-TERM GOALS

The ultimate objective of this research program is to identify and obtain a predictive understanding of the physical and biological processes responsible for variations in the sediment volume inhomogeneity field of marine sediments. To achieve this goal we are studying formative processes occurring on the sediment surface (e.g., biogenic mound formation, ripple development), as well as processes occurring within the seabed (e.g., bioturbation and compaction). The approach to these areas of interest is predominantly field-oriented, with a secondary emphasis on model development.

## OBJECTIVES

The objective of this project, which is part of the High-Frequency Sediment Acoustics DRI, is to quantitatively document the patterns of sediment volume inhomogeneities at the Fort Walton Beach, FL study site. A secondary objective is to estimate temporal rates of change of volume inhomogeneities.

## APPROACH

We measure quantitatively the sediment volume inhomogeneity (SVI) field using a digital x-radiography system and an in situ resistivity profiler (IRP). Precisely located (using an acoustic triangulation system) and oriented cores are collected by divers at multiple separation lengths, transported to the ship and immediately radiographed onboard. Brightness data are transformed to bulk density data, based on empirical laboratory correlations. The bulk density fields are described and analyzed using a variety of spatial statistical measures, as well as classical sedimentological nomenclature. Independent estimates of bulk density profiles are made using a diver-deployed resistivity profiler (thesis research of Cara Fritz). In addition, deliberate-tracer bioturbation experiments are conducted during the experiment. The purpose of this measurement is to document rates of biological mixing that may contribute to temporal changes in the SVI field.

## WORK COMPLETED

The SAX99 field campaign occurred from 3 October to 12 November 1999, and focused on a 500 by 500-m area of the shallow (18-m depth) seafloor off Ft. Walton Beach, Florida. Within the study region, a large number of acoustical (e.g., BAMS, XBAMS, TAPS) and environmental (e.g., grain size, porosity) measurements were made. Because the latter are mostly destructive (i.e., they remove or some how disturb portions of sediment), it was not possible to co-locate exactly acoustical and environmental measurements. Therefore, a large number of environmental samples were collected at a variety of spatial lags with the goal of statistically characterizing the study region. During a 2-week cruise, the digital x-radiography system was used to collect roughly 50 images of the SAX99 sediment column, and IRP was used to collect roughly 80 profiles of resistivity. These efforts were spread over a dozen sites within the study region. In addition, deliberate tracer experiments (cf. Wheatcroft et al. 1994) were successfully completed at three sites within the study region.

## RESULTS

Preliminary analyses indicate that there is little spatial variability in the SVI field over the study region. Both the digital x-radiographs and the resistivity profiles indicate a <5- mm thick, near-surface region of rapidly decreasing porosity, underlain by a region 10's of cm thick in which porosity was essentially uniform. In addition, IRP profiles indicate little bottom type specificity. That is, profiles collected on ripple troughs and crests were, on average, similar to those collected on biogenic mounds. Digital x-radiographs indicate that the dominant source of small-scale variability in SVI within the study area is shell debris. Ranging in size from 1-30 mm, the concentration, vertical distribution and orientation of the shell debris is presently being studied (Figure 1).

## IMPACT/APPLICATIONS

For a range of frequencies, digital radiographs have the greatest potential for providing acousticians with high-quality data on the sediment volume inhomogeneity field. Further development of this research topic has wide-ranging applications.

## TRANSITIONS

None are presently known, however, the digital x-radiography system would seem to have potentially wide application in the Fleet.

## RELATED PROJECTS

Sediment volume inhomogeneity data are being used by DJ Tang and Darrel Jackson (APL-UW) in their acoustical modeling efforts. In addition, Dick Bennett (Seaprobe) and I are comparing macro- (using the digital x-radiography system) and micro-scale views of the sediment fabric.

## REFERENCES

Wheatcroft, R.A., I. Olmez and F.X. Pink. 1994. Particle bioturbation in Massachusetts Bay: Preliminary results using a new deliberate tracer technique, Journal of Marine Research, 52, 1129-1150.

## PUBLICATIONS

Richardson, M. D. et al., including R.A. Wheatcroft. Overview of SAX 99: Environmental Considerations, IEEE Journal of Ocean Engineering (sub judice).

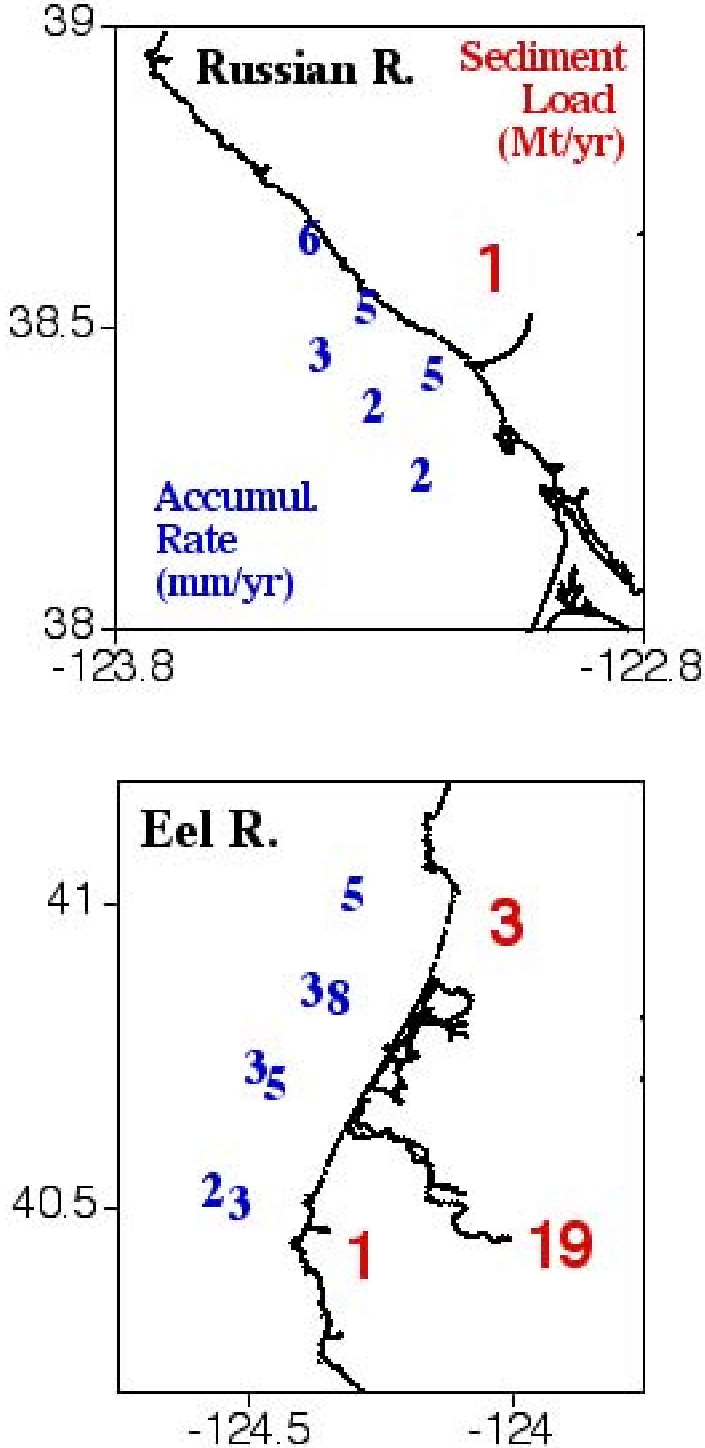


***Figure 1. Example of preliminary image processing involving shell debris. The upper left panel depicts a raw digital x-radiograph with its vertical trend in brightness (due to beam geometry). The trend is removed (upper right) and then a brightness based segmentation algorithm is used to compute a binary image (lower left). Based on independent information on the size distribution of shell debris (unknown at this time), a size filter can be applied resulting in the panel in the lower right.***